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Be it known that Frank Peters, a citizen of the United States of America, residing at Chattanooga, Tennessee 37421USA; Jim Prettyman, a citizen of the United States of America, residing at Powder Springs, Georgia 30127 USA; Danny Freeman , a citizen of the United States of America, residing at Ringgold, Georgia, 30736 USA; and Terry Bandy, a citizen of the United States of America, residing at Rocky Face, Georgia 30740 USA, have invented certain new and useful improvements in a

METHOD OF MANUFACTURING A CARPET HAVING AN ODOR CONTROL AGENT

of which the following is a specification.

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METHOD OF MANUFACTURING A CARPET HAVING AN ODOR CONTROL AGENT

FIELD OF THE INVENTION

The present invention is directed towards a method for applying an odor control agent to carpet or other floor coverings made from fibrous material at various manufacturing stages. The odor control agent controls odor associated with deposits, particularly spills of organic material, on carpet fibers or other fibrous materials.

BACKGROUND OF THE INVENTION

Carpet is widely used as a floor covering in both residential and commercial application. Carpet is very versatile, offering numerous qualities including durability, aesthetics, comfort, safety, warmth and quietness. With modern manufacturing and dyeing techniques, carpeting may also be provided in almost any color, texture and pattern. Carpet may be manufactured from diverse types of materials including natural materials such as wool or cotton, or synthetic materials from various polymers such as polypropylene, polyamide, etc. Each of these materials will be referenced herein as carpet fibers and includes these fibers utilized in other fiber floor coverings. The majority of carpet, particularly for residential and commercial use, is manufactured from synthetic polymer material such as polypropylene, polyester, and polyamide. Among the polyamides, T-6 and T-6,6 are common. Regardless of the material used in the manufacture, a typical synthetic yarn manufacturing process involves first extruding the carpet fiber and converting to continuous filament or staple yarns through a series of air entangling, drafting, carding, mechanical

twisting, or other means to create a single threadline made up of numerous individual fibers made up of various natural and synthetic materials.

Various finishes and lubricants are applied at each of these stages to either enable further processing, provide identifications, enhance performance properties, or help enhance final carpet appearance. Threadlines, in various combinations, are wound and rewound on bobbins at various stages in the manufacturing process before being ready to be dyed prior to tufting into carpet, or, in the case of solution-dyed yarns in which the fibers are intrinsically dyed in the extrusion process, to be tufted. Methods to pre-dye yarn, in addition to that mentioned for solution-dyed extruded yarns, include the skein dye method in which spun or filament yarns are dyed in vats or tanks with or without pressure, and a stock dyed method in which spun fibers are vat dyed before making them into yarn. In both cases, further mechanical twisting and heat setting processes occur before the yarn is ready to be tufted. Finishes and lubricants are also applied to the yarn after these stages in the manufacturing process.

Carpet floor coverings made from polypropylene, polyester, wool and nylon may be susceptible to odors and staining from organic sources. In order to prevent staining, it is known in the industry to use stain blockers. The stain blockers act to prevent or reduce the ability of organic dyes, particularly acid dye colorants from chemically reacting with and bonding to the nylon. The carpets are also commonly coated with a fluorochemical or hydrocarbron anti-soiling agent. These agents reduce the tendency of soil to adhere to the fiber. Examples of such stain blockers are illustrated in U.S. Patent numbers 4,680,212 and 4,925,707.

Generally, fluorochemicals are topically applied to carpet. One method is to form an aqueous dispersion of the fluorochemical and then spray that dispersion on the top face of the carpet. Another method is to make an aqueous based foam containing the fluorochemical and then apply the foam to the top

face of the carpet. Heat is usually applied to drive off excess water and to fix the fluorochemical to the carpet fibers.

In addition to staining, especially in residential locations, the possibility of deposits of organic matter such as feces or urine from babies and pets can result in not only soiling of the carpet but also a lingering odor and may, in extreme cases, require the replacement of the carpet. Furthermore, bacteria may grow from the soil organic matter. These bacteria may have the potential of causing mold and mildew. Some of these bacteria may themselves give rise to odor due to incomplete digestion of organic material. There have been attempts to reduce the presence and number of bacteria present in carpet by utilizing various anti-microbial agents such as described in U.S. Patent Nos. 4,110,504 and 5,024,840. The use of anti-microbials, while reducing the number of bacteria associated with carpet, may raise other concerns such as the potential that some of the bacteria may become resistant to effects of the anti-microbials.

Many bacterial and fungal genera are known for use in odor control due to their capability for producing enzymes that are capable of breaking down organic material. Such bacteria are particularly useful where the organic material, if allowed to remain, will give rise to malodors. Several such bacterial and fungal genera such as Bacillus, Lactobacillus, Enterobacter, Streptococcus, Rhizopus, Nitrosomonas, Nitrobacter, Pseudomonas, Alcaligens and Klebsiella, among others, are known for use in such applications with Bacillus being the most prevalent in use in various applications.

For example, preparations of active Bacillus in a vegetative form suitable for spraying or otherwise distributing on a deposit, especially of pet urine and feces, on a carpet for controlling odor are presently marketed by The Bramton Company of Dallas, Texas under the trademark OUTRIGHT. The bacterial preparations are used to deodorize a deposit by application directly on the deposit.

However, application of an odor treatment after installation of the carpet is only available if an individual notices the organic deposit. This may be difficult for commercial carpet installations and in some residences due to the size of the carpet or location of the organic deposit.

Accordingly, there is a need in the art for an effective odor treating agent that can be manufactured into carpet fibers and other similar floor coverings so that it does not have to be applied by the carpet owner.

There is also a need in the art for an odor treating agent that does not have to be reapplied in the event of a new deposit, such as a dormant or sporulated bacterial form, that would become active only when needed.

There is a further need in the art for a manufacturing technique that would bind such an odor treating agent into carpet fibers in a manner which is cost effective.

Furthermore, there is a need in the art for a manufacturing technique that provides a carpet with an anti-soiling property and odor treating property that is easy and economical to conduct.

SUMMARY OF THE INVENTION

The present invention is a method for manufacturing a floor covering comprising of fibers. The method includes providing a carpet fiber and applying an odor control solution to the fiber carpet. The odor control solution includes a bacteria spore blend and a bacteria spore blend binder wherein the solution has a pH within the range of 1 to 12.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be more readily understood from a reading of the following specifications and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown and wherein:

Fig. 1 is illustrates the application of an odor treatment solution to a pre-dyed carpet fiber;

Fig. 2 is a block diagram illustrating an exemplary method of performing the present invention wherein the odor control agent and the odor control agent binder are topically applied to the tufted carpet yarn simultaneously with the application of an anti-soiling treatment before the carpet yarn is dried during the continuous dyeing process.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is directed towards a method for applying an odor control agent to carpet fibers or other floor coverings made of fibrous materials during the carpet manufacturing process or to the fibers themselves prior to the carpet manufacturing process for controlling odor associated with deposits of organic material. For the purposes of this disclosure, the odor control agent is a bacterial form or forms referenced herein as the "bacteria spore blend".

Many bacterial genera are known to produce enzymes capable of breaking down organic material. Such bacteria are particularly useful where the organic material, if allowed to remain, will give rise to malodors. Several such bacterial genera such as Bacillus, LactoBacillus, Enterobacter, Streptococcus,

Nitrosomonas, Nitrobacter, Pseudomonas, Alcaliaens and Klebsiella amongst others are known for use in such applications, with Bacillus and Lactobacillus being the most prevalent in use in various applications. Strains of bacteria from any of the above noted genera are useful in practicing the present invention. Preferably, the bacterial preparation for use in the present invention is one or more strains of Bacillus or LactoBacillus. More preferably, the strains of bacteria for use in the present invention are selected from Bacillus lichenifonnis, Bacillus pasteurii, Bacillus laevolacticus and Bacillus amyloliquefaciens. Each of these species have characteristics which make them most effective against particular types of organic materials.

All of these species are capable of enhanced anaerobic and aerobic growth. Bacillus pasteurii is known for superior lipase production, while Bacillus laevolacticus has a very fast germination cycle. Bacillus amyloliquefaciens is high in production of protease enzymes.

The selection of the strains of bacteria for use in the present invention may depend upon many factors. One such factor is the nature of the organic material most commonly expected for the particular application. For example, in a commercial application, the most commonly expected deposits would be soil tracked in from out-of-doors, beverages such as coffee, tea, other food and the like, especially in a restaurant environment, and possibly, inks or toners for printers and other office equipment. Many of these materials are high in fatty components so the bacterial preparation may be enhanced for strains having high activity against such materials. One example of such a bacteria is Bacillus pasteurii described above.

In a residential environment, the nature of the deposits may differ with out-of-doors soils. For example, beverages, food and urine and feces from pets and children being the most commonly encountered. Depending upon the nature of the deposited material, the bacteria spore blend may be selected to contain strains having enhanced activity against such materials. Another factor

which may affect the nature of the deposit is the geographical location of the installed carpet. This factor would especially relate to the nature of deposits of out-of-doors soil and to the nature of food deposits. Different regions are known to have different soil types and different regions may also have differences in the foods commonly consumed due to cultural and environmental factors. In addition, the temperature of the carpet to be treated will influence the activity of the bacteria. Depending on the strain selected, the bacteria will tend to exhibit enhanced activity at higher temperatures. At lower ambient temperatures, more active strains may be desired.

The bacteria spore blend will typically comprise one or more strains selected from the genera and species described above. When utilizing a mixture of more than one strain, each of the individual strains may comprise between 3% and 97% of the total of the bacteria present in the bacteria spore blend. Depending upon the bacteria, these percentages are based on the total cell number or colony forming units or the total mass of the bacterial preparation. For the Bacillus, the percentages are based on total cell number. Preferably, each of the strains is present in sufficient numbers to make up 10% to 70% of the total bacteria in the bacteria spore blend. When mixtures of more than two strains are employed, each of the strains is preferably present in an amount of from 20% to 40% of the total bacteria in the bacteria spore blend. Particularly preferred bacteria spore blends for general use in almost all applications are as follows:

	% of total bacteria	
Species	Range	Preferred
Bacillus licheniformis	20-60	40
Bacillus pasteurii	10-30	20
Bacillus laevolacticus	10-30	20
Bacillus amylolicruefaciens	10-30	20

In a preferred embodiment of the present invention, an effective amount of bacteria spore blend comprising one or more strains selected from the group consisting of Bacillus licheniformis, Bacillus pasteurii, Bacillus laevolacticus and Bacillus amyloliquefaciens, and combinations thereof, is provided in a state in which the bacteria spore blend may be applied to a carpet fiber or other fibrous material. The effective amount of bacteria spore blend is a sufficient amount of bacteria to provide a relatively uniform coverage of the fiber such that when any portion of the carpet is exposed to a deposit of an odor causing organic material, the bacteria will undergo rapid growth and consume the odor causing material. The factors which can affect the number of bacteria to be used relate in most part to the nature of the carpet material. Such factors include the nature of the fiber in terms of the material, e.g. nylon or polypropylene and the like, the characteristics of the yarn in the terms of the denier and number of filaments and the characteristics of the fiber in terms of the number of yarns and the twist. These factors relate to the nature of the carpet in terms of the weight (oz) and height of the yarns. All of these factors will affect the amount of exposed surface of the fibers which might be covered by the bacteria spore blend. For most applications on carpet, between about 10^6 and 10^8 cells per gram of carpet fiber having a weight between about 20oz and 40oz is most effective with 10^7 cells per gram of carpet fiber being most preferred.

The bacteria spore blend may be provided as a simple aqueous preparation of a suspension of the Bacillus species in a suitable aqueous carrier, such as in distilled water, tap water, a saline solution, foam, spray or other such aqueous solutions. Preferably, the aqueous composition comprises the odor controlling dormant bacterial strain or strains and an effective amount of bacteria spore blend binder. The binder may be a fluorochemical, hydrocarbon , or any other topically applied treatments such as anti-stats, yarn spin finishes, lubricant, etc.

When utilized with the bacteria spore blend binder the Bacillus species may be provided as active cells. The term "active cells" encompass cells in a vegetative form capable of immediate growth when exposed to food sources usually utilized by the bacteria. The term "dormant cells" is intended to encompass cells which are in a state which are required to be activated before they can undergo growth. One example of a dormant cell is a sporulated form of the bacteria where the spores must undergo activation and germination before growth of the bacteria can occur.

As noted above, due to the protective effects of the bacteria spore blend binder, the active bacteria would be protected from the possible effects of environmental factors. If the bacteria are provided in an active form, it is thought that they may become dormant after the application by undergoing sporulation until a deposit of organic material is encountered. In a preferred embodiment, the bacteria are provided in an already dormant or sporulated form. By providing the bacteria in a dormant or sporulated form, the bacteria are further protected from environmental factors which may prove detrimental to active bacterial cells. These environmental factors may include low moisture or humidity, as the carpet or other fibrous material would generally be kept in a dry state. Other factors may include exposure to heat, chemical agents, radiation from sunlight as well as the exposure to air for those strains which may be predominantly anaerobic.

The sporulated or dormant strains of bacteria become activated and undergo germination in response to being exposed to organic material including organic material which can cause odors. The factors which promote the activation of the dormant or sporulated bacteria include the moisture and various organic compounds present in the deposit of organic material. Once activated, the bacteria undergo growth and replication, consuming the organic material in the deposit until the material is consumed. After the material is consumed, the bacteria will then become dormant by undergoing sporulation to

await exposure to another deposit of organic material. It is thought that the bacteria will also be somewhat cannibalistic, in that as the bacteria break down after the depletion of the organic material, the degradation products of the break down would be utilized as a food source by other of the bacteria. Once the potential energy source is reduced and the number of bacteria is also reduced, it is thought that the remaining bacteria undergo sporulation to return to a dormant state.

The bacteria spore blend odor control treatment can be applied to the carpet fibers at various stages of the manufacturing process. Additionally, the bacteria spore blend odor control treatment may be applied directly to the fibers prior to manufacturing. The following examples illustrate exemplary techniques for practicing the present invention.

Figs. 1 and 2 illustrate an exemplary method of performing the present invention wherein the bacteria spore blend is topically applied to carpet utilizing a bacteria spore blend binder. Various carpet fiber compositions are suitable for bacteria spore blend application. For the purposes of this disclosure, the carpet fiber may consist of nylon 6, nylon 6,6, olefin, olefin nylon blends, extruded solution dyed nylon, extruded solution dyed polyester, polypropylene, wool, cotton or acrylic or polyester fibers or combination thereof. Each of these carpet fiber compositions are equally suitable for practicing the present invention and may be utilized in other fibrous floor coverings.

For this embodiment, the bacteria spore blend is applied to the carpet fibers to provide the carpet fibers with effective resistance to organic odors. Preferably, the bacteria spore blend binder is provided in solution with the bacteria spore blend. Preferably, the bacteria spore blend binder may be a fluorochemical, a hydrocarbon, or other topically applied treatment. The advantage of using a specific bacteria spore blend binder is that additional characteristics may be incorporated into the carpet fibers. For example, if a

fluorochemical binder is utilized, anti-soiling properties may be incorporated into the carpet as well as acting as a binding agent for the bacteria spore blend. Hereinafter, the bacteria spore blend and bacteria spore blend binder are referred to as an odor treatment agent.

In the preferred embodiment, prior to application to the carpet, the odor treatment agent is diluted with a diluting agent which is preferably water to provide an odor treatment solution. Preferably, the odor treatment agent is intermixed with the water such that the odor treatment agent is 7.5% to 10.8 % of the odor treatment solution wherein the bacteria spore blend component is of an amount resulting in a product on carpet as a percentage of face yarn weight of .9% to 1.29% . Additionally, the odor treatment solution has a pH range between 1.0 to 12.0 with the preferable pH range being from 5.0 to 8.0. The odor treatment solution may be applied to the carpet fibers prior to manufacturing of the carpet or onto the carpet directly. If the odor treatment solution is applied to the carpet fibers prior to manufacturing, the carpet fibers must be pre-dyed.

When the odor treatment solution is applied to the carpet during manufacturing, it is important that the odor treatment solution be applied after all dying processes are complete. In the preferred embodiment, the odor treatment solution is applied at 15% wet add on, however wet add ons of between 5% to 25% are acceptable. Once applied, the odor treatment solution is cured. While the odor treatment solution may cure at ambient temperature, it is preferred that the carpet with the odor treatment solution is cured in a dry heat zone wherein the face temperature of the fibers are exposed to normal drying temperatures.

It has been found by the inventors, that two different properties may be applied to the carpet simultaneously saving product costs and manufacturing time. For instance, when utilizing an anti-staining agent such as a fluorochemical or a hydrocarbon as the bacteria spore blend binder during the

odor treatment process, if a sufficient amount of fluorochemical or hydrocarbon is utilized in the odor treatment solution, the carpet will also be able to incur an anti-staining property. This requires that an additional amount of fluorochemical or hydrocarbon be present in the odor treatment solution other than an amount which would function solely as a binder for the bacteria spore blend.

If a fluorochemical is utilized as a bacteria spore blend binding agent, the fluorochemical component of the odor treatment solution is preferably 1.25% to 4.0% fluorine with a product on carpet of 150ppm fluorine to 600ppm fluorine. Accordingly, with this preferred embodiment, the carpet incorporates an odor control agent resulting from the incorporation of the bacteria spore blend bound to the carpet fibers via utilization of the fluorochemical in addition to incorporating an anti-soiling agent via the presence of the additional fluorochemical. This is the preferred embodiment as the carpet is treated with two separate desired treatments simultaneously resulting in cost savings.

In addition to spraying the odor treatment solution onto the carpet, the odor treatment solution may be applied via foam. When applied as a foam, the odor treatment solution has the same characteristics as previously described. When applied as foam the odor treatment solution may be required to be associated with a foam stabilizer and is preferably applied at a blow ratio of between 4:1 to 10:1.

Alternatively, a hydrocarbon may be utilized as the bacteria spore blend binder. When a hydrocarbon known as PM3180, provided by 3M Corporation of St. Paul Minnesota, was utilized, the odor treatment agent consisted of between 2 to 4% of the odor treatment solution with the product on yield percentage of face fiber of between .3% and .6% and applied at pH of between 1.0-12.0 with the preferable range being between 5.0 to 8.0 to achieve the desired anti-soiling properties.

In yet another alternative embodiment, the bacteria spore blend can be topically applied to carpet yarns using a yarn spin finish binder. Effective resistance to organic odors can be achieved by applying effective amounts of bacteria spore blend during the extrusion process. At this stage in the manufacturing process, the carpet yarn consists of extruded solution dyed nylon, extruded solution dyed polyester and polypropylene. The details of the extrusion process are known to those skilled in the art and thus it is beyond the scope of this disclosure to examine it in detail here. For the purposes of this embodiment, the extruded carpet yarn is treated with bacteria spore blend, either in liquid form or by utilizing an aqueous medium as described in detail in the embodiment previously described, at levels of product on carpet of 0.9% to 1.29%.

In yet another alternative embodiment of the present invention, bacteria spore blend may be applied to pre-dyed carpet fibers in liquid form, along with fluorochemical compounds, at a stage upstream from the final winding process that turns the carpet fibers into yarn.

Although various preferred embodiments of the present invention have been described herein in detail, it will be appreciated by those skilled in the art, that variations may be made thereto without departing from the spirit of the invention or the scope of the appended claims.